The electrical change on the papilla parotidea by tongue stimulation and by injection of collected saliva

著者名(英)	Koshiro INOMATA, Hisayoshi ISHII, Isao OOTA, Masashi KURAHASHI
journal or publication title	東日本歯学雑誌
volume	23
number	2
page range	189-195
year	2004-12-31
URL	http://id.nii.ac.jp/1145/00008896/

〔ORIGINAL〕

The electrical change on the papilla parotidea by tongue stimulation and by injection of collected saliva

Koshiro INOMATA[1], Hisayoshi ISHII[1], Isao OOTA[2] and Masashi KURAHASHI[3]

[1]Department of Oral Physiology, School of Dentistry
[2]Department of Communication Disorders, School of Psychological Science
[3]Department of Medical Science, School of Nursing & Social Services
Health Sciences University of Hokkaido

ABSTRACT

The amplitude of the electrical change from parotidea areas with tongue stimulation shows various amplitudes i.e. the amplitude of the electrical change from the papilla parotidea have been shown as 18 mV, but six other records (three from the mucous membrane around the papilla parotidea, and three from the cutis over the parotidea gland) show it to be under 0.8 mV. When the stimulated saliva was flowing through the system hear, the time till culmination of the electrical change, which was recorded from near the papilla parotidea was shorter than the time till culmination far from the papilla parotidea. The saliva which evoked the higher electrical change was collected, and about 4 minutes after the stimulation (when the electrical level of the papilla parotidea had returned to the before stimulation (resting) level), this collected saliva was injected into a Carlson type cup. The electrical change evoked by this injection and the amplitudes of the evoked electrical charge were 75～90% of the amplitude of the electrical change by tartaric acid stimulation.

Key words : electrical change, papilla parotidea, tongue, saliva

INTRODUCTION

Electrical phenomena accompanying the process of salivary secretion from glands in animals were first described Bayliss and Bradford[1] and further studies have been reported by a number of investigators. Iwama and Shinjo[2] reported that the electrical changes on the papilla parotidea closely resembles that of the salivary flow from the human parotidea gland and they suggested that this electrical change is caused by the action of currents of the parotidea gland. Thereafter this suggestion has been supported by many investigators.

Inomata et al.[3], recorded the electrical change on the papilla parotidea and in two other places (the

受付：平成16年９月30日

cutis over the parotidea gland and around the parotidea) simultaneously, and found the amplitude of the electrical change on the papilla parotidea as 10 mV but the amplitude from the two other places were be low 0.3 mV. This discrepancy among the amplitudes on the papilla parotidea and from two other places are difficult to explain by the action current mechanism.

Inomata et al.[4-9] suggested that the electrical change on the papilla parotidea is not caused by the action currents of the parotidea gland but by the saliva itself.

This report aims to clarify the relation between the secretion of parotidea saliva and the electrical change on the papilla parotidea.

MATERIALS AND METHODS

The subject was a healthy 57-year-old male with a parotidea secreting about two times more than others. About 1 h after the Carlson type cup[10], was placed over the papilla parotidea, the tongue was stimulated with 3% tartaric acid. A small disc of cotton wool, about 1 cm in diameter, was saturated with tartaric acid solution (3%) and was quickly rubbed (ca. 0.4 ml) three times along the margin of the tongue from tip to base at the ipsilateral side of the Carlson type cup. When the effect of the stimulation reached a constant level after a small number of successive 5 min interval tongue stimulations, the collection of saliva and recording of electrical changes were started.

The saliva of the parotidea gland was collected through this Carlson type cup, and the electrical change was simultaneously lead out from this cup. A diagram of the manner of the collection of saliva and

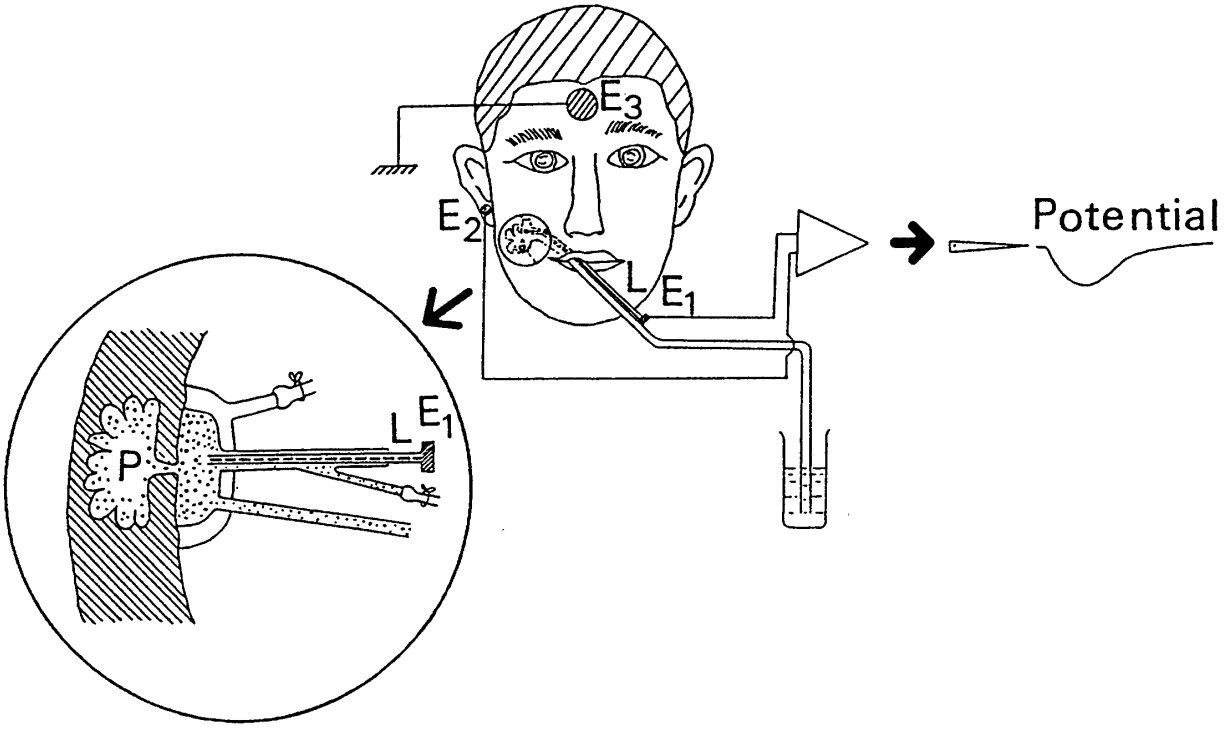

Fig. 1 Block diagram of the experiments.
P : Parotidea gland.
L : Lead wire (vinyl tube with cotton thread filled with saline, termed "thread electrode").
E_1 and E_2 : Ag-AgCl electrodes (8mm diameter : miniature skin electrode/Nihon Kohden).
E_3 : Ag-AgCl electrodes (3X3cm).

the leading out of the electrical change from the papilla parotidea is shown in Fig. 1.

A vinyl tube (1mm in diameter) with a cotton thread inside was filled with saline, at one end of this tube and the tip of this thread was pulled about 2 mm inside from the edge of the cross section of the vinyl tube, as the tip of the thread should not enter the saliva flow, and this end of the tube was placed on the papilla parotidea through the drainage of a Carlson type cup. The other end of this vinyl tube was connected to an Ag－AgCl electrode (8mm in diameter : miniature skin electrode, Nihon Kohden, Japan) using E.E.G. paste and attachment, and the lead of this Ag－AgCl electrode was connected to the input (+) port of the DC amplifier (micro－electrode amplifier). This type of electrode (pulled thread tip) showed smaller noise and errors due to larger inaccuracies in the potential on an electrode than on other types of electrodes by preliminary experiments, and this system was named a "thread electrode". Another Ag－AgCl electrode was placed on the lobulus auriculae using E.E.G. paste at the ipsilateral side of a Carlson type cup and was connected to the input (－) port of a DC amplifier and was used as the indifferent electrode, and a larger Ag－AgCl electrode (3 cm) was placed on the center of the forehead and used as the body earth electrode (Fig. 1). Ag－AgCl electrodes (8 mm in diameter) were placed on the cutis over the parotidea gland, and suction type electrodes (trial production) were placed on the mucous membrane around the papilla parotidea and these electrodes were used as the different electrode. The electrical change on the papilla parotidea and other places were continuously recorded on paper via a DC amplifier and pen －recorder system.

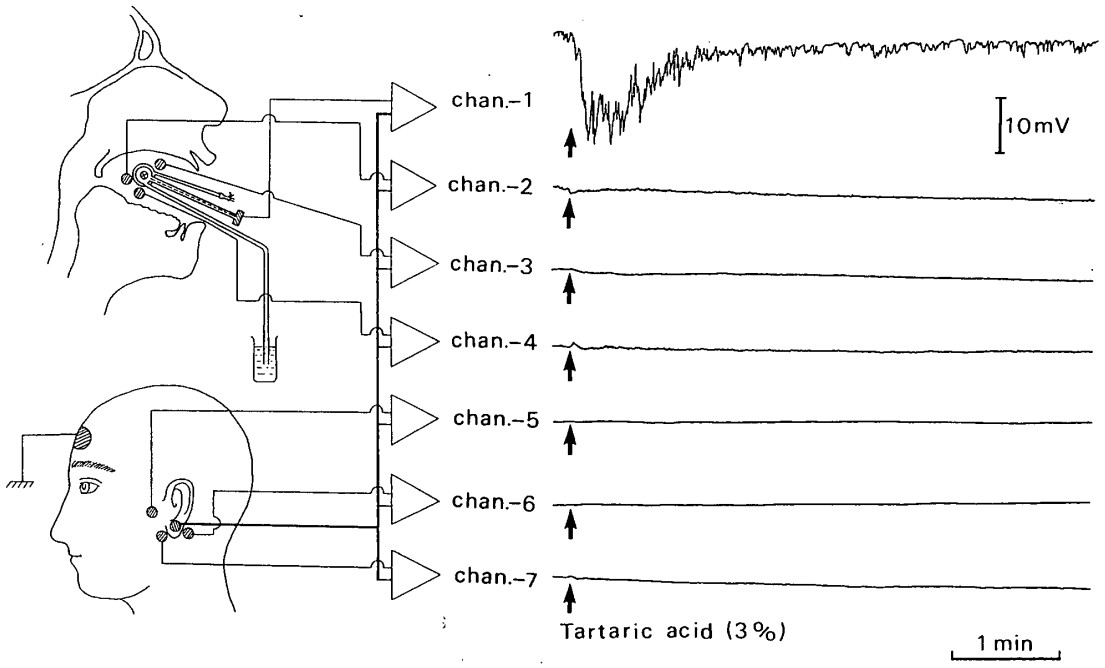

Fig. 2 The electrical change on the papilla parotidea and at six other places.
Top record : electrical change on the papilla parotidea (18mV).
Next three records : electrical changes on the mucous membrane around the papilla parotidea.
Lower three records : electrical changes on the cutis over the parotidea gland.

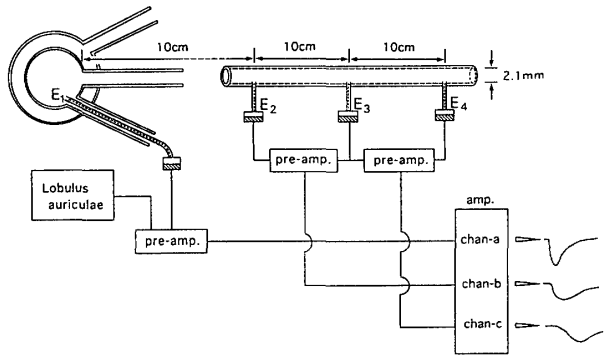

Fig.3 Recording method for the electrical changes during parotidea saliva passing each of the electrodes in the salivary drain.
E_1, E_2, E_3, and E_4 : thread electrodes.
Ag-AgCl electrode(8mm diameter)was connected with lobulus auriculae using E.E.G. paste.

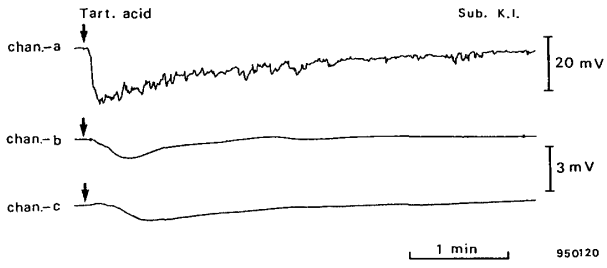

Fig.4 Relation between electrodes and the occarrence of the time of culmination.
The time of culmination on ch-a was about 10 sec after stimulation, on ch-b about 25 sec, and on ch-c about 40 sec.

RESULTS

The electrical changes from the papilla parotidea and six other places were simultaneously recorded as shown in Fig. 2. The channel 1 record shows the electrical change on the papilla parotidea and the amplitude of this change is about 18 mV. The records of channels 2, 3, and 4 show the electrical changes on the mucous membrane around the papilla parotidea, the records of channels 5, 6, and 7 show the electrical changes on the cutis over the parotidea, the amplitude of these electrical changes were all lower than 0.8 mV. It was considered that the difference in electrical change between channel 1 and the other channels may be related to the existence (channel 1) or absence (other channels) of salivary flows. Assuming that this electrical change is related to the salivary flows, the correlation between the time of culmination of the electrical change and that of the salivary flow was determined using a device as shown in Fig. 3. The secreted saliva from the parotidea gland flows through the tip of electrode (E_1) and, in order, of through three other electrodes (E_2, E_3, and E_4) in this device, and the leads of E_1 and of the electrode on the lobulus auriculae were connected to channel a ; E_2 and E_3 were connected to channel b ; and E_3 and E_4 were connected to channel c. The records of the electrical changes from these electrodes are shown in Fig. 4. Fig. 4 shows that, the variation in the time of culmination in the electrical changes depend upon the distance from the papilla parotidea, i.e., the time of culmination for E_1 and the auriculae (channel a) is about 10 sec ; for E_2 and E_3 (channel b) if is about 25 sec ; and for E_3 and E_4 (channel c) is about 40 sec.

The electrical characteristic of the collected saliva was examined with the method shown in Figs. 5 and 6. The saliva secreted through a Carlson type cup was collected into a syringe (2 ml type) as in Fig. 5 A, and about 4 min later the collected saliva was injected into a Carlson type cup as in Fig. 5B. As shown in Fig. 6, after tongue stimulation the secreted saliva was collected during the high electrical response (bar and solid triangle), and till about 4 min after the tongue stimulation when this electrical response returns to the level before the stimulation (resting) ; At this collected saliva was again injected into a Carlson type cup (bar and open triangle). At this injection, an electrical change was again recorded even with the pa-

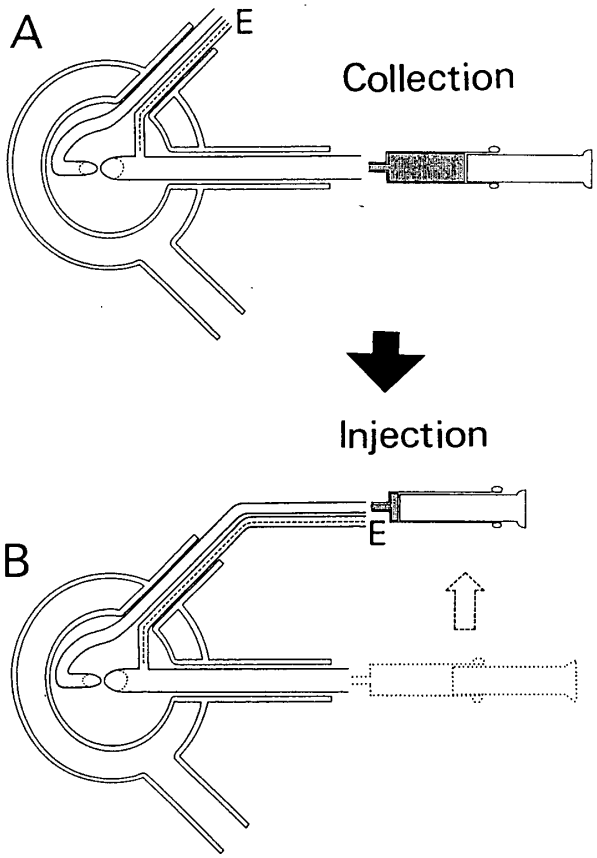

Fig.5 Diagram of the collection of the parotidea saliva and injection of this collected saliva.
A : Secreted saliva which evoked larger electrical changes was collected into a syringe(2 ml type).
B : This collected saliva was injected about 4minutes after the stimulation,
E : Thread electrode.

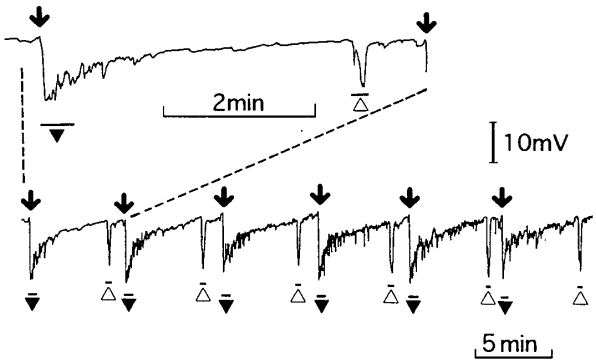

Fig.6 The electrical change on the parotidea by tongue stimulation and by injection of collected saliva.
Upper record : The recording speed of this curve is five times the lower record recording speeds.
Lower record : The record from the papilla parotidea by stimulation (six times) and by injection of collected saliva (six times) respectively.
↓ : tongue stimulation (3% tartaric acid).
▼ : collection of saliva and its duration.
△ : injection of collected saliva and its duration.

rotidea gland in resting condition.

The amplitude of the electrical change with injection of the collected saliva showed 75－90% of the amplitude with tongue stimulation. The preliminary experiments, suggested that the amplitude of the electrical change with the injection of the collected saliva depends on the condition of fitting of the Carlson type cup on the papilla parotidea and it is not easy to maintain this in a good condition (Inomata et al.[8]), and this experiment also established that the injection of the collected saliva does not change salivation from the papilla parotidea.

DISCUSSION

Iwama and Shinjo[2] have reported that the electrical phenomena of the papilla parotidea accompanying human saliva secretion are caused by an action current on the parotidea gland, and this is generally accepted. By the experiment here (Fig. 2), the maximum amplitude in electrical change on the papilla parotidea shown was about 18 mV (chan-1) and the electrical change on the other six portions (from chan-2 to chan-7) showed slighter amplitudes (lower than 0.8 mV) in the simultaneous recording, and the differ-

ence in the amplitude of the electrical change of the papilla parotidea and other six parts portions could not be explained with Iwama and Shinjo's action current theory[2].

Inomata et al.[4] reported that the time course of the electrically change on the papilla parotidea was parallel to the variation in the electrical charged saliva which was caused by the total ions in the saliva (termed as the total charge : Inomata et al.[4]). This suggested that the movement in the electrical change depends upon the intensity of the electrically charged saliva, and to test this the relation between the moving, electrically charged saliva and the movement of the culmination in the electrical change was investigated using the apparatus shown in Fig. 3 (here each recording electrode is set at a different distance from the papilla parotidea), and the results are shown Fig. 4.

The results show that the times of culmination of the electrical change in the middle record (channel b in Fig. 4) is delayed about 15 sec from the times of culmination of the upper record (channel a) and that the time culmination of the lower record (channel c) is also delayed about 15 sec from the middle record (channel b). This suggests that the differences of these times of culmination were caused by the electrically charged saliva moving through the drain in the apparatus (Fig. 3).

The amplitude of the electrical change on the papilla parotidea (channel a) was compared with the amplitude of the electrical change on the drain in this system (channels b and c). The amplitude of the former is about ten times that of the latter, and the cause of this may be suggested to be as follows : 1) more or less saliva around each electrode affects the electrical generation (the difference in electric generation around each electrode) ; 2) differences in the mixture ratio of stimulated saliva to resting saliva ; 3) differences in the position of the leads in this system ; 4) the effect of input impedance in the preamplifier system. Most details of the cause for these differences will be determined in further studies.

The relation between the electrically charged saliva and the electric changes was investigated using the apparatus as shown Fig. 5, and the charged in the electrical changes on the papilla parotidea which was evoked by tongue stimulation and by injection of the collected saliva is shown in Fig. 6. The amplitude of these electrical changes evoked by the injection of collected saliva were 75～90% (12～15 mV) for ordinary electrical change (15～17 mV) evoked by tongue stimulation (tartaric acid 3%). From this, it was concluded that the electrical change on the papilla parotidea mainly depends upon the intensity of the electrically charged saliva (electric generator of power in the saliva) and not on the action current of the parotidea gland as described by Iwama and Shinjo[2], of course, this intensity of the electrically charged saliva was caused by a summation of the various ions in the saliva (total charges : Inomata et al.[4]).

REFERENCES

1. Bayliss, W.M. and Bradford, J.R. : On the Electrical changes accompanying secretion. *J. Physiol. (Lond.),* **6** : 13－16, 1885.

2. Iwama, K. and Shinjo, T. : A method for leading off action currents from human salivary gland and for recording velocity of secretion. *Tohoku J. Exp. Med.,* **52** : 223－229, 1950.

3. Inomata, K., Takakuwa, M., Tamagawa, M., Kurahashi, M. and Nakamura, H. : A study on the parotid salivation and changes in electrical potential. II. Some problems in the time－course of secretory potentials in human period. *Higashi Nippon Det. J.,* **3** : 21－26, 1984.

4. Inomata, K., Takakuwa, M., Iwase, K. and Kurahashi,

M. : A study on the parotid salivation and changes in electrical potential. III. The relation between the electrical potential accompanying salivation in human parotid and ion concentration in parotid saliva. *Higashi Nippon Det. J.,* **3** : 161－167, 1984.

5. Inomata, K., Suzuki, M., Hoshi, M. and Kurahashi, M. : A study on the parotid salivation and changes in electrical potential. IV. The relation between electrical changes on the parotidea and electrical changes of saliva and saline. *Higashi Nippon Det. J.,* **11** : 189－193, 1992.

6. Inomata, K., Suzuki, M., Hoshi, M., Oota, I. and Kurahashi, M. : The potential differences between two solutions with different concentrations of electrolytes using filter paper as a bridge. *Higashi Nippon Det. J.,* 14 : 71－**76**, 1995.

7. Inomata, K., Oota, I. and Kurahashi, M. : Relation between the secretory potential of parotid glands and the generated of collected salivas. *Higashi Nippon Det. J.,* **14** : 193－200, 1995.

8. Inomata, K., Oota, I., Ishii, H., Yamane, Y. and Kurahashi, M. : Electrical changes induced by injection of collected saliva on the papilla parotidea. *Higashi Nippon Det. J.,* **16** : 279－285, 1997.

9. Inomata, K., Oota, I., Ishii, H., Yamane, Y. and Kurahashi, M. : The movement of parotid saliva and time lag of appearance of electrical change. *Higashi Nippon Det. J.,* **17** : 67－74, 1998.

10. Carlson, A. and Crittenden, A.L. : The relation of ptyalin concentration to the diet and to the rate of secretion of the saliva. *Am. J. Physiol.,* **26** : 169－177, 1910.